SmartDriveDuo-10
MDDS10

User's Manual

V1.0

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1. INTRODUCTION

SmartDriveDuo-10 is one of the latest smart series motor drivers designed to drive medium power brushed DC motor with current capacity up to 30A peak (few seconds) and 10A continuously. This driver is designed specially for controlling differential drive mobile robot using RC controller. Nevertheless, MDDS10 also can be controlled using analog joystick or microcontroller (PWM, Serial). MOSFETs are switched at 16 KHz to ensure quiet operation and no annoying whining sound. Besides, it also equipped with a microcontroller unit to provide smart features such as multiple input mode and thermal protection.
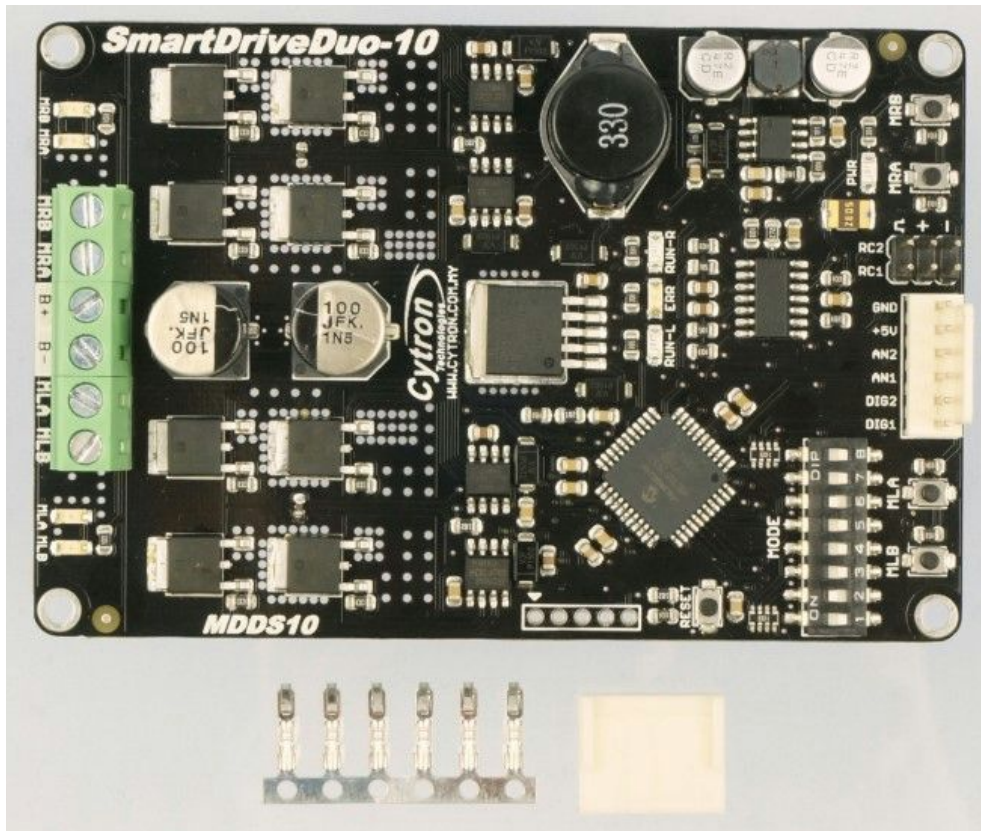
SmartDriveDuo-10's feature makes driving a robot with differential drive a truly plug and play experience.

Some of the features for SmartDriveDuo-10 are summarized as below:
- Bi-directional control for dual brushed DC motor.
- Support motor voltage from 7V to 35V.
- Maximum current up to 30A peak (few seconds), 10A continuously.
- 16 KHz switching frequency for quiet operation.
- Battery low voltage indicator.
- Battery over voltage indicator.
- Thermal protection.
- Multiple input modes: RC, Analog, PWM, Simplified Serial and Packetized Serial.
- On board push buttons for fast test and manual operation.
- **No polarity protection for V motor**.
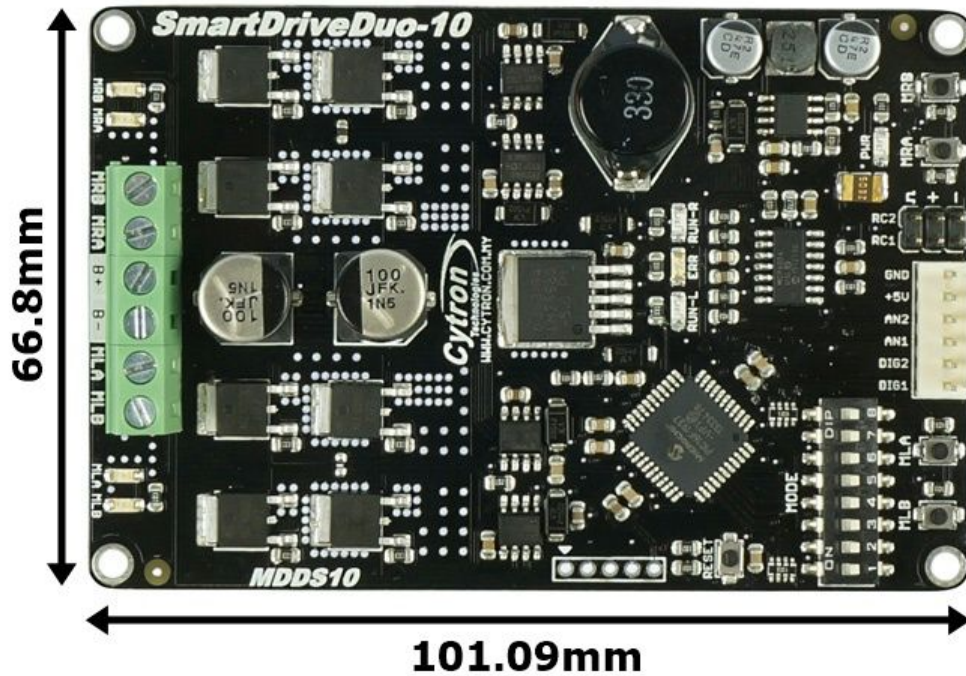
2. PACKING LIST

Please check the parts and components according to the packing list. If there are any parts missing, please contact us at sales@cytron.com.my immediately.

- 1 x SmartDriveDuo-10
- 6 x Terminal pin for 2510
- 1 x 6-way Connector Housing

3. PRODUCT SPECIFICATIONS

Dimension:

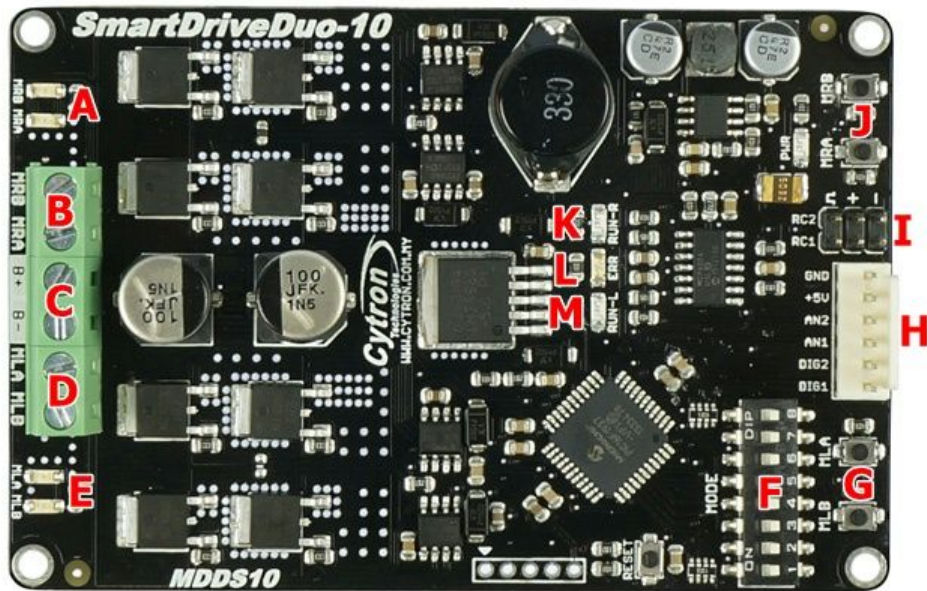Absolute Maximum Rating of SmartDriveDuo-10

No	Parameters	Min	Typical	Max	Unit
1	Input Voltage (Motor Supply Voltage)	7	-	35	V
2	I_{MAX} (Maximum Continuous Motor Current)*	-	-	10	A
3	I_{PEAK} – (Peak Motor Current) **	-	-	30	A
4	V_{IOH} (Logic Input – High Level)	1.3	-	5	V
5	V_{IOL} (Logic Input – Low Level)	0	-	0.7	V
6	5V Output Current	-	-	500	mA

*   *Depends on the room temperature.*
**   *Must not exceed 1 second.*

4. BOARD LAYOUT

Label	Function
A	Motor RIGHT LED Indicator
B	Motor RIGHT Terminal Block
C	Power Supply Terminal block
D	Motor LEFT Terminal Block
E	Motor LEFT LED Indicator
F	Mode Selection DIP Switch
G	Motor LEFT Test Button
H	Analog/PWM/Serial Input Pin
I	RC Input Pin
J	Motor RIGHT Test Button
K	Motor RIGHT Run LED
L	Error LED
M	Motor LEFT Run LED

FUNCTION Description:

Motor RIGHT LED Indicator
Indication for current flow and direction for motor RIGHT. If LED MRA turns on, means current flows from output MRA to MRB. Vice versa.

Motor RIGHT Terminal Block
Connect to motor RIGHT at your mobile robot. User can tie the wire to the terminal block or solder the wire directly to the pad at bottom layer.

Power Supply Terminal Block
Connect to power source. User can tie the wire to the terminal block or solder the wire directly to the pad at bottom layer. **No polarity protection**, please double check before power up.

Motor LEFT Terminal Block
Connect to motor LEFT at your mobile robot. User can tie the wire to the terminal block or solder the wire directly to the pad at bottom layer.

Motor LEFT LED Indicator
Indication for current flow and direction for motor LEFT. If LED MLA turns on, means current flows from output MLA to MLB. Vice versa.

Mode Selection DIP Switch
User can select different input mode by setting the DIP switch.

Motor LEFT Test Button
Fast test to check driver functionality for motor LEFT. If MLA is pressed, current flows from output MLA to MLB. Vice Versa.

Analog/PWM/Serial Input Pin

No	Pin Name	Description
1	DIG1*	1: Digital signal (Direction) for motor LEFT. 2: Serial Simplified, Serial Packetized.
2	DIG2	Digital signal (Direction) for motor RIGHT.
3	AN1	Analog/PWM signal for motor LEFT.
4	AN2	Analog/PWM signal for motor RIGHT.
5	+5V	+5V output. **Do not** connect to another 5V source.
6	GND	Ground.

*DIG1 can accept 2 types of input.
**Please refer to INPUT MODE section for more detail.

RC Input Pin
This pins specially for RC receiver input wire. RC1 for forward/reverse and RC2 for steering.

Motor RIGHT Test Button
Fast test to check driver functionality for motor RIGHT. If MRA is pressed, current flows from output MRA to MRB. Vice Versa.

Motor RIGHT Run LED
Turns on when motor RIGHT is running. If signal error received for motor RIGHT, it will blink.

Error LED

Number of Blinks	Error	Description
Off	No Error	No error has been detected.
2	Input Error	Invalid or no input detected.
3	Under Voltage	The battery voltage is low.
4	Over Voltage	Supply voltage is over the limit. MDDS10 will not operate.
5	Over Temperature	Board temperature is high.
6	Shutdown	Board temperature is too high! Motor automatically stop.

Motor LEFT Run LED
Turns on when motor LEFT is running. If signal error received for motor LEFT, it will blink.

5. POWER SUPPLY

SmartDriveDuo-10 supports input voltage ranges from 7V to 35V. The recommended power sources are:

- 6 – 18 cells NiMH or NiCd battery.
- 2 – 6 cells LiPo or Li-Ion battery.
- 7V – 35V sealed lead acid battery.
- 7V – 35V power supply (**Must be in parallel with a battery with same voltage**).

The power source can be connected to SmartDriveDuo-10 either via the terminal block, or soldered directly to the pad at the bottom layer. **There is no polarity protection on MDDS10, please double check the connection before connecting to power source.**

NOTE:
1. If a power supply that cannot sink current is being used (example: bench top and AC to DC switching power supply), the input voltage will rise when the driver is regenerating (motor is slowing down). Thus, it is important to connect a battery with same voltage in parallel with the power supply to absorb the current generated by the motor. Else, the input voltage might rise to a level where SmartDriveDuo-10 will be destroyed permanently or the power supply trigger protection mode.

6. MOTOR CONNECTION

Similar to the power supply, connection to the motor can be made either via the terminal block, or it can be soldered directly to the bottom layer pad.

For Mixed mode, especially for RC input mode (or Breakout board with Joystick soldered), each terminal block must be connected to the same side of the motor. For example, **left terminal block connected to motor LEFT and right terminal block connected to motor RIGHT**. Then, user can test it by controlling the motor by using RC controller. If the motor give wrong direction, reverse the polarity of the motor connection at the terminal block.

7. SAFETY FEATURES

SmartDriveDuo-10 incorporates some safety features which make it robust and reliable motor driver. Below are the detailed descriptions for each feature.

a. **Input Error (Error LED blinks 2 times)**
   Every time SmartDriveDuo-10 is power up, the input data must be 'stop' (for RC, Analog, PWM input mode). This feature prevent the driver from sudden run, especially when the driver accidently reset.

b. **Under Voltage Warning (Error LED blinks 3 times)**
   Upon power on, SmartDriveDuo-10 will automatically detect the number of cells for the battery. If it is set to LiPo, when the input voltage falls below 3.0V per cell during operation, the error LED will blink to warn the user. However, the power to the motor will be maintained and will not be cut out. Thus, it is user's responsibility to stop the motor driving and replace battery to avoid further damage to the battery. If other types of battery is used to power the board (e.g NiMH, NiCD, SLA), the under voltage warning will still be shown. In this case, user may ignore the warning and he/she needs to estimate when to replace the battery by him/herself.

c. **Over Voltage Protection (Error LED blinks 4 times)**
   If over voltage is detected (> 35V), SmartDriveDuo-10 will not operate.

d. **Over Temperature Protection (Error LED blinks 5 times)**
   SmartDriveDuo-10 is equipped with a temperature sensor to monitor its operating temperature. It will gradually lower down the duty cycle percentage base on the temperature as shown below:

Temperature Range (ºC)	Duty Cycle (%)
< 50	100
50 – 55	90
55 – 60	80
60 – 65	70
65 – 70	60
70 – 80	50
80 – 85	40
85 – 90	30
90 – 95	20
95 – 100	10
100 – 105	5
> 105	0 (Shutdown)

e. **Shutdown (Error LED blinks 6 times)**
   Shutdown will occur when SmartDriveDuo-10 temperature become too high (temperature > 105ºC). As a result, motor will stop automatically. The driver for respective channel starts operate again when temperature decrease less than 70ºC.

Note: MDDS10 does not come with polarity protection, please double check the

connection before powering up.

8. INPUT MODE

When the SmartDriveDuo-10 is powered up, RUN-L LED, ERR LED and RUN-R LED will running once. After that, the input mode will be read from the DIP switch and retained as long as the driver is powered. If you wish to change the input mode, you will need to change the setting on the DIP switch and **press the "RST" reset button**, or power cycle the driver (Turn it off and turn it on again).

SmartDriveDuo-10 supports four different types of input mode (RC, Analog, PWM and Serial). The DIP switch settings for each mode and the function for input pin are summarized on the following page.

You can find DIP switch setting and other information at the back of SmartDriveDuo-10

DIP Switch	1	2	3	4	5	6	7	8
RC	⊙	⊙	**Channel:** ⊙ ⊙ : Mixed ⊙ 1 : Independent Right 1 ⊙ : Independent Left 1 1 : Independent Both		⊙ : Linear 1 : Exponential	⊙ : RC 1 : MCU	**Battery Monitor:** ⊙ ⊙ : LiPo ⊙ 1 : NiMH 1 ⊙ : SLA 1 1 : Off	
Analog	⊙	1	⊙					
PWM	1	⊙	1			⊙ : Locked Anti-Phase 1 : Sign Magnitude		
Serial Simplified	1	1	⊙	**Baudrate:** ⊙ ⊙ ⊙ : 2400 ⊙ 1 ⊙ : 4800 ⊙ 1 1 : 9600	1 ⊙ ⊙ : 19200 1 ⊙ 1 : 38400 1 1 ⊙ : 57600 1 1 1 : 115200			
Serial Packetized	1	1	1	**Address:** Start from ⊙ ⊙ ⊙ to 1 1 1				

8.1 RC INPUT MODE

In RC input mode, the speed and direction of the motor is controlled by the signal from the standard hobby radio control transmitter and receiver, or a microcontroller generating the similar signal.

NOTE: The RC transmitter must be ON before power up the SmartDriveDuo-10.

RC Input mode is selected by setting the **SW1 & SW2** to **0 (Down)**. SW3 – SW6 can be configured depending on the requirement of the user.

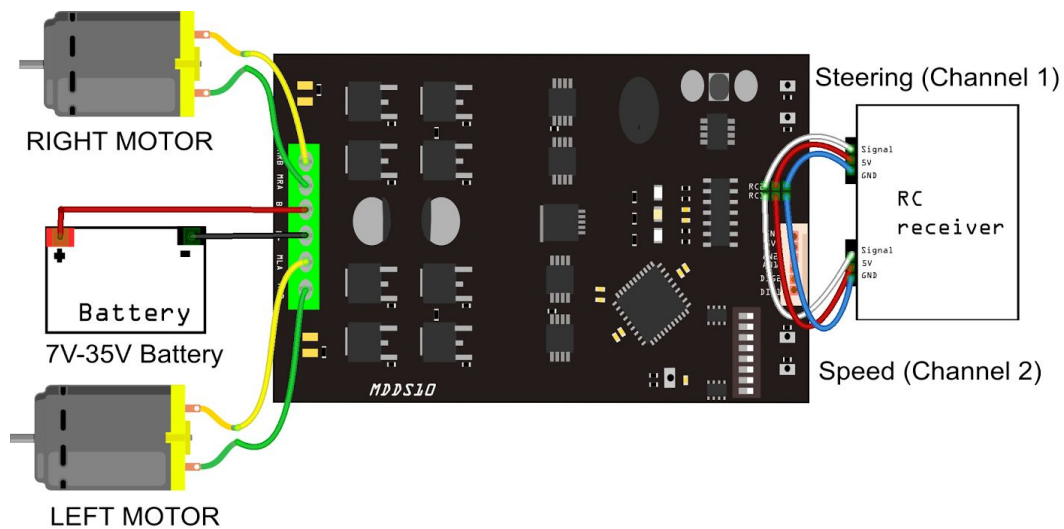| Input Mode	SW1:SW2 00	**RC Input Mode**
Single/Mix Mode	SW3:SW4 00	**Mixed** – The motor speed is controlled by channel RC1 and direction is controlled by channel RC2. Recommended this mode if controlled using RC transmitter/receiver.
	01	**Independent Right** – Only motor Right will active, motor Left will inactive. Motor Right is controlled by channel RC2.
	10	**Independent Left** – Only motor Left will active, motor Right will inactive. Motor Right is controlled by channel RC1.
	11	**Independent Both** - Both motor is active and can be controlled individually through channel RC1 and RC2. Recommended this mode if controlled using Microcontroller.
Exponential Mode	SW5 0	**Off** – The speed is linear with the input signal. This is for low to medium speed motor.
	1	**On** –The response to input is exponential and thus soften the control around the center zero speed point. This is suitable for high speed and very sensitive motor.
MCU Mode	SW6 0	**Off** – The center point will be calibrated upon power up. Timeout occurs after lost of signal for 100ms and the motor will be stopped for safety purpose.
	1	**On** – The center point is fixed at 1.5ms and the timeout feature is disabled. Motor will continue to run with previous speed if new signal is not detected. This is useful when a microcontroller is used to control the motor. The microcontroller does not need to send the pulse continuously to the SmartDriveDuo-10. Instead, it only needs to send a single pulse when the speed or direction of the motor needs to be changed.

0 – OFF   1 – ON   X – Don't Care

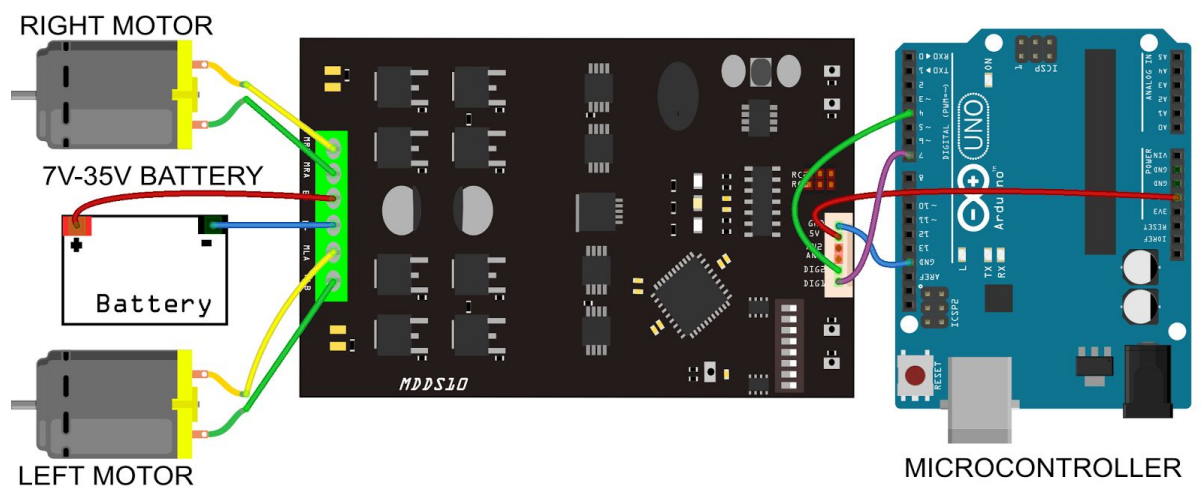Figures below show the connection in RC mode.

RC Mode with RC Transmitter/Receiver (Mixed), DIP switch

1 2 3 4 5 6 7 8
0 0 0 0 0 0 0 0

RC Mode with Microcontroller (Independent Both), DIP switch

1 2 3 4 5 6 7 8
0 0 1 1 0 1 0 0

8.2 ANALOG/PWM INPUT MODE

In Analog/PWM input mode, the speed and direction of the motor is controlled by the analog voltage or PWM signal. The valid input range is 0 – 5V and it's very easy to control by using a potentiometer. For example, the motor can be controlled by a joystick or foot pedal with potentiometer.

> **NOTE:** The Analog/PWM signal to stop the motor (2.5V if Sign-Magnitude mode is off, 0V otherwise) must be available when the SmartDriveDuo-10 is turned on. Else, the driver will show Input Error until the correct signal is available.

Analog input mode is selected by setting **SW1 to 0 (Down) and SW2** to **1 (Up)**. PWM input mode is selected by setting **SW1 to 1 (Up) and SW2** to **0 (Down)**. SW3 – SW6 can be configured depending on the requirement of the user.

	SW1:SW2	
	01	**Analog Input Mode** – The input is analog signal. The filter capacitor is not connected and the input signal is not filtered. SW1 is for Input 1 while SW2 is for Input 2.
Input Mode	10	**PWM Input Mode** – The input is PWM signal. The filter capacitor is connected and the input signal is low pass filtered to be an analog signal. SW1 is for Input 1 while SW2 is for Input 2. SW2 must be set to 0 if Sign-Magnitude mode is turned on.
	SW3:SW4	
	00	**Mixed** – The motor speed is controlled by channel RC1 and direction is controlled by channel RC2. Recommended this mode if controlled using Breakout board with Joystick soldered.
	01	**Independent Right** – Only motor Right will active, motor Left will inactive. Motor Right is controlled by channel RC2.
Single/Mix Mode	10	**Independent Left** – Only motor Left will active, motor Right will inactive. Motor Right is controlled by channel RC1.
	11	**Independent Both** - Both motor is active and can be controlled individually through channel RC1 and RC2. **Recommended this mode if controlled using Microcontroller.**
	SW5	
	0	**Off** – The speed is linear with the input signal. This is for low to medium speed motor.
Exponential Mode	1	**On** –The response to input is exponential and thus soften the control around the center zero speed point. This is suitable for high speed and very sensitive motor.
	SW6	
	0	**Locked Anti-Phase** – Motor stops when the input signal is 2.5V. Motor moves in one direction when the input is < 2.5V and in another direction when the input is > 2.5V. Recommended this mode if controlled using Breakout board with Joystick soldered.
Sign-Magnitude Mode	1	**Signed Magnitude** – AN1 and AN2 controls the speed of the motor. Motor stops when the input is 0V and run at full speed

		when the input is 5V. DIG1 and DIG2 is digital inputs and it controls the direction of the motor respectively.

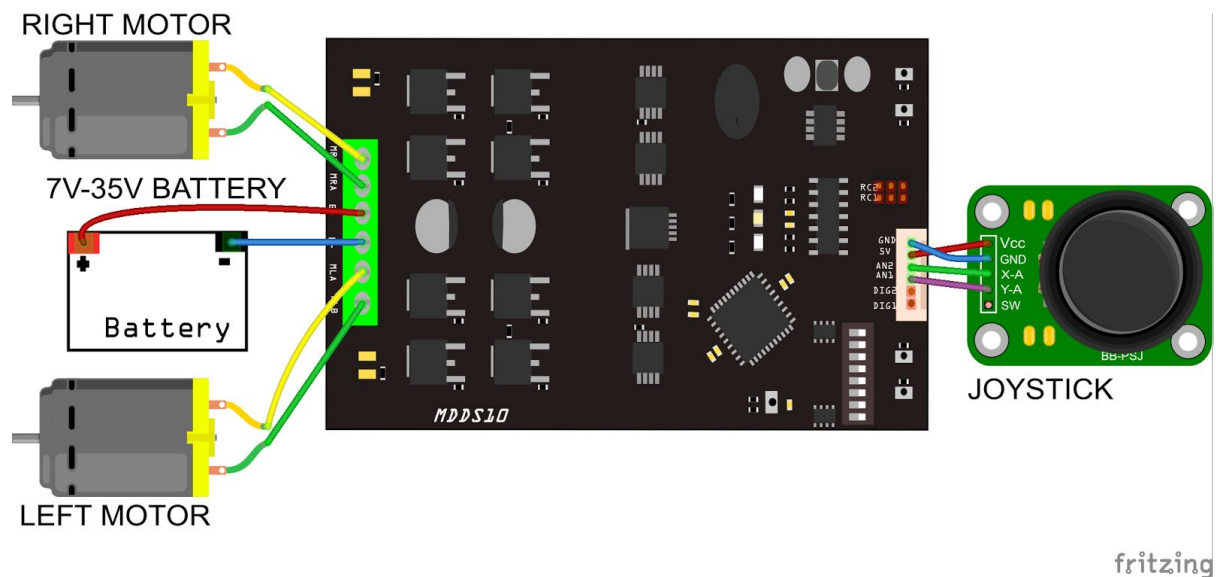0 - OFF   1 - ON   X - Don't Care

Figures below show the connection in analog/PWM input mode.

Analog input mode with Joystick board (Mixed), DIP switch
DIP Switch Setting
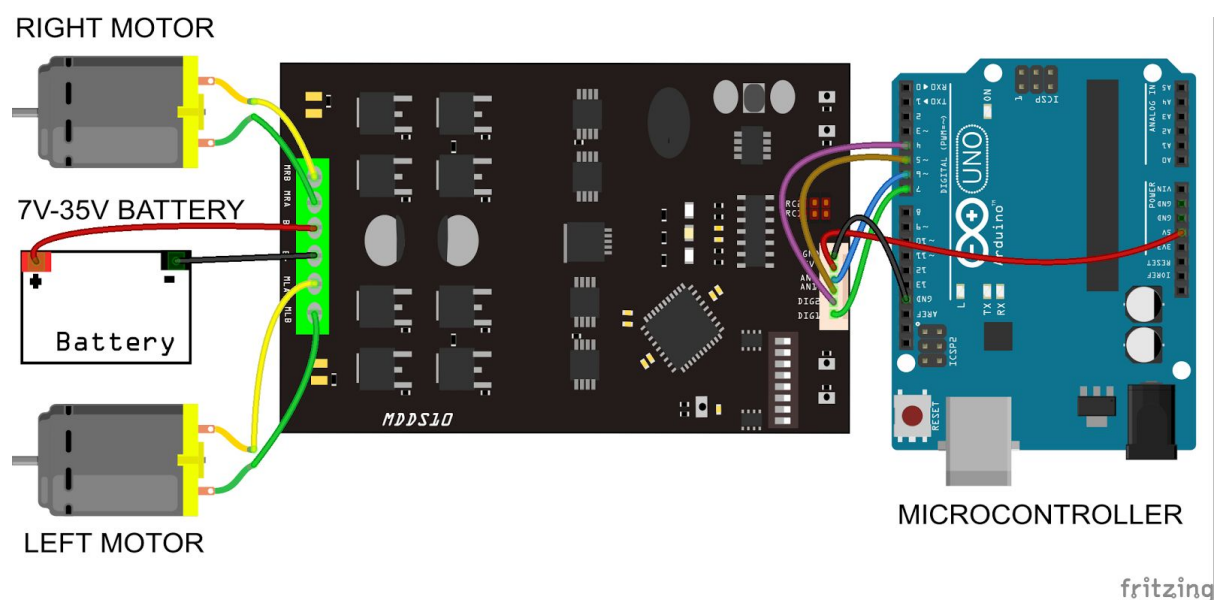1 2 3 4 5 6 7 8
0 1 0 0 0 0 0 0

PWM input mode with microcontroller (Independent Both), DIP switch
DIP Switch Setting
1 2 3 4 5 6 7 8
1 0 1 1 0 1 0 0

8.3 SERIAL SIMPLIFIED MODE

In Simplified Serial mode, SmartDriveDuo-10 is controlled by using the UART interface. DIG1 pin is the UART Rx. DIG2, AN1 and AN2 pins are not used in this mode.

A single byte of data is all you need to control the speed and direction for each motor. First MSB bit is to select which motor to control, and the rest bits is to control.

Bit	7 (MSB)	6	5	4	3	2	1	0 (LSB)
Function	Channel	Direction	Speed					

Bit 7 (Channel): 0 - motor LEFT, 1 - motor RIGHT.
Bit 6 - 0: Control motor direction and speed.

Example: Value in Decimal
- 0 or 64 - motor LEFT stop.
- 63 - motor LEFT full forward.
- 127 - motor LEFT full reverse.
- 128 or 192 - motor RIGHT stop.
- 191 - motor RIGHT full forward.
- 255 - motor RIGHT full reverse.

Simplified Serial mode is selected by setting **SW1, SW2 to 1 (Up) and SW3** to **0 (Down)**. SW4 – SW6 are used to select the UART baud rate.

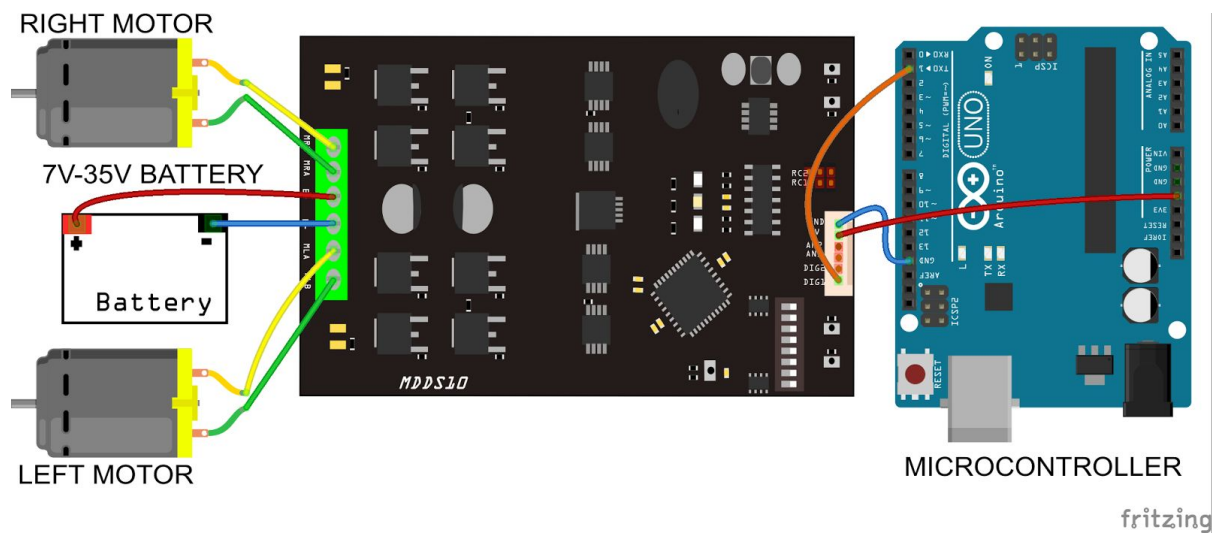| Input Mode	SW1 - SW3 110	**Simplified Serial Mode**
UART Baud Rate	**SW4 - SW6** 000 001 010 011 100 101 110 111	**Baud Rate** 1200 2400 4800 9600 19200 38400 57600 115200

0 - OFF   1 - ON   X - Don't Care

Figure below shows the connection to multiple SmartDriveDuo-10 in Simplified Serial Mode.

Simplified Serial mode with microcontroller (9600bps), DIP switch
DIP Switch Setting
1 2 3 4 5 6 7 8
1 1 0 0 1 1 0 0

8.4 SERIAL PACKETIZED MODE

In Packetized Serial mode, SmartDriveDuo-10 is controlled by using the UART interface. DIG1 pin is the UART Rx pin. DIG2, AN1 and AN2 pins are not used in this mode. To control the motor, data sent to the driver must be in 4 bytes packet format which includes a header, address, command and checksum. Up to 8 units of SmartDriveDuo-10 can be connected together to a single microcontroller UART Tx pin.

Besides that, the SmartDriveDuo-10 also incorporates an Auto-Baud feature in Packetized Serial mode. When the driver is first powered up, the host microcontroller must send a header byte (Decimal 85 or hex 55) once to the driver. The driver will then calculate the baud rate automatically based on this byte. After that, SmartDriveDuo-10 is ready to read full packet (4 bytes) and the baud rate cannot be changed without power recycle (power off and on) or reset button.

NOTE:
1. When the driver is powered up and waiting for the header byte, the error LED will blink and indicate that there is input error.
2. SmartDriveDuo-10 may take up to 500ms to start up after power is applied. Sending the header byte for auto baud during this time period may cause undesirable results. Please allow one-second delay between applying power and sending the header byte.

Packetized Serial mode is selected by setting **SW1, SW2 and SW3** to **1 (Up)**. SW4 – SW6 are used to select the address.

Input Mode	**SW1 - SW3** 111	**Packetized Serial Mode**
UART Address	**SW4 - SW6** 000 - 111	**0 - 7**

0 - OFF   1 - ON   X - Don't Care

A packet consists of 4 bytes and the format is shown in the following table.

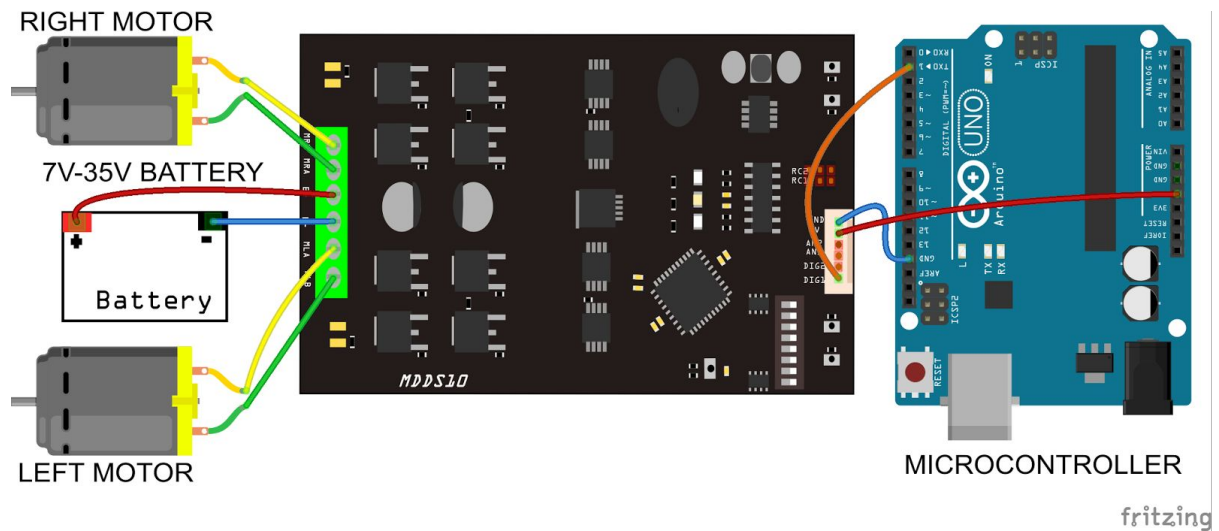| Byte	Name	Value (Decimal)	Description
1	Header	85	To indicate the start of packet.
2	Channel & Address	Channel: Bit 3 Address: Bit 2 - 0	Used to identify the driver when multiple units are connected together. The address bits (bit 2 - 0) must match the address configured with the DIP switch. Bit 3 represent which motor to be controlled, 0 for motor LEFT and 1 for motor RIGHT.
3	Command	0 – 255	Value 127 stops the motor, 0 is full reverse and 255 is full forward.
4	Checksum	0 – 255	The value for checksum must be the result of Header + Address + Command

Figure below shows the connection to multiple drivers in Packetized Serial Mode.

Packetized Serial mode with microcontroller (Address = 0), DIP switch

DIP Switch Setting

1 2 3 4 5 6 7 8
1 1 1 0 0 0 0 0

9. WARRANTY

- Product warranty is valid for 12 months.
- Warranty only applies to manufacturing defect.
- Damaged caused by misuse is not covered under warranty
- Warranty does not cover freight cost for both ways.

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